

# New insights to Neoproterozoic glaciation in Brazil from stratigraphic studies of carbon and sulfur isotopic change and Re/Os age constraints

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The discovery of bituminous shale and carbonate deposited across several glacial cycles in Neoproterozoic sediments of Brazil offers a unique laboratory for the study of the chemical evolution of the oceans and biological evolution of micro-organisms during rapid and profound environmental and climatic change. The research is centered on four cores through the glaciogenic Vazante Group and overlying Lapa Formation on the Sai Francisco craton. We have collected samples at high resolution throughout the cores for time series carbon and sulfur isotope analyses, with particular focus on four discrete horizons of organic-rich shale and carbonate for biomarker geochemistry and Re/Os age constraints. Stratigraphic and sedimentologic evidence, including ice rafted debris and glendonite (a pseudomorph after a carbonate mineral that most commonly forms between -1.9 and 7°C) support the view that these organic-rich intervals (concentrations reach a peak of 4 wt.% in one of the studied horizons) were either syn-glacial or deposited during post-glacial transgression. For example, the Lapa Formation was deposited during maximal flooding atop a widespread sequence boundary, which is overlain by dropstone-laden diamictite and local accumulation of iron-formation, as well as finely laminated carbonate, siltstone and > 10 m of organic- and pyrite-rich shale. The post-glacial interpretation also fits with the carbon isotope trend across basal Lapa strata, which reveals a strong negative carbon isotope anomaly. Sulfur isotope analyses of finely disseminated sulfides in the Lapa shale reveal remarkable S-34 enrichments (up to +30‰) in basal beds of the formation, similar to post-glacial lithofacies worldwide. The extremely positive sulfur isotope compositions of these sulfides could be associated with high rates of bacterial sulfate reduction in an anoxic deep glacial ocean with low sulfate concentrations. Notably, sulfur isotope values in the Lapa Formation decline up section by as much as 20‰, which may reflect decreased sulfur isotope fractionation as oceanic sulfate concentrations increased along with primary productivity. Results of Re/Os age determinations for the shale horizons will be presented. Following established procedures, we will use standard Carius tubes with mixed Re/Os spikes, but two different digestion solutions will be evaluated. One method will use reverse aqua regia, which typically attacks all phases, while the second will use chromic oxide and sulfuric acid, which attacks only hydrogenous phases and neither dissolves quartz nor feldspar, the two main detrital components. Once extracted, purified Re and Os will be analyzed by negative thermal ionization mass spectrometry. These measurements may reveal the age of the Vazante Group, which is presently only broadly constrained by chemostratigraphic techniques, as well as the duration and timing of glacial pulses and biogeochemical monitors of the Neoproterozoic environment.

